

California Environmental Protection Agency



**QUANTIFICATION OF PERMEATION AND EVAPORATIVE EMISSIONS
FROM PORTABLE FUEL CONTAINERS
(June 2004)**

Stationary Source Testing Branch
Monitoring and Laboratory Division

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Introduction

To determine the effectiveness of spill-proof portable fuel containers to control diurnal emissions (permeation and evaporative), the California Air Resources Board (ARB) tested 15 containers over a period of 175 days using Phase II Certification fuel. Each container was filled with CERT fuel and allowed to soak in order to reach equilibrium. During the soak period, each spout was cycle tested in order to demonstrate real world conditions. Following the initial soak period, the containers were then placed into a Sealed Housing for Evaporative Determination unit (SHED) and subjected to California variable temperature profiles.

Test Protocol

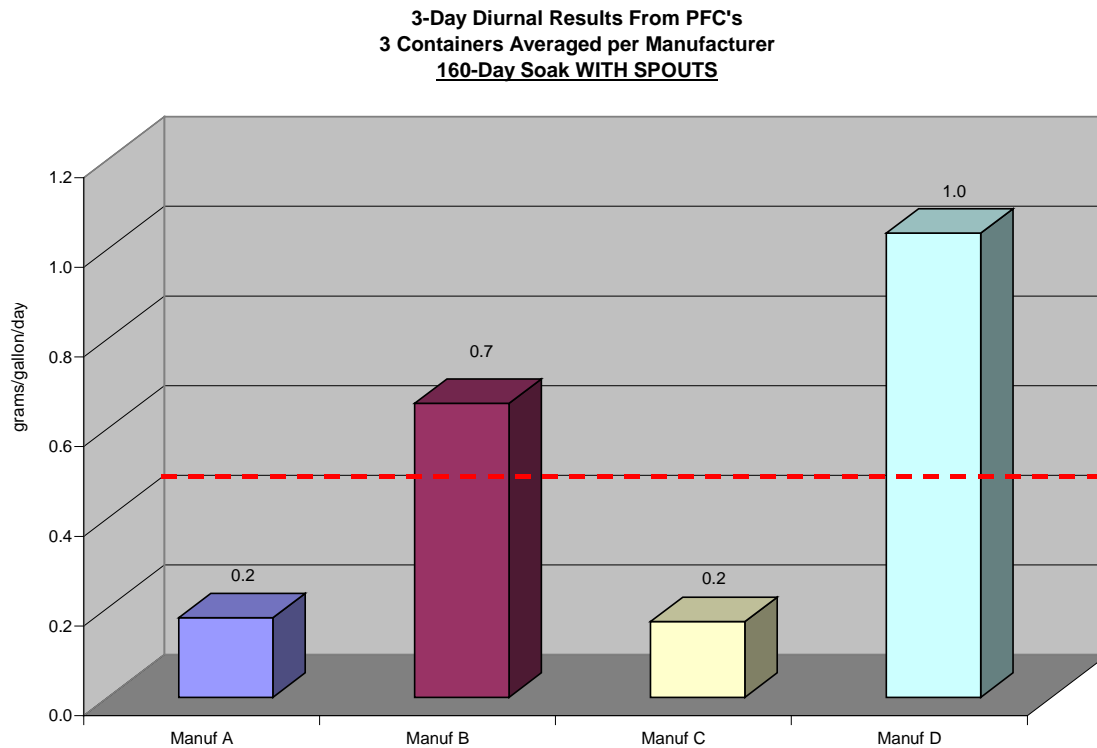
Staff filled various size containers to 50% capacity with CERT fuel and then installed spill-proof spouts on each container. Once sealed, each spout was then actuated 500 times over a 5-week period in order to subject the spouts to gasoline and test for durability.

After 160 days had lapsed, the containers were subjected to 4 diurnal cycles (65°F-105°F-65°F) with spouts installed. The containers were weighed daily to observe the weight loss (emission loss) rates. This type of testing was performed to gain an understanding of the baseline diurnal emissions resulting from both evaporation and permeation. Following testing, the spouts were then removed from the containers and each container was permanently sealed using HDPE coupons welded over each container opening. The purpose was to examine permeation so that the evaporation emissions could be quantified.

Test Results: Combined Evaporation and Permeation (Diurnal)

Figure 1 summarizes the combined evaporation and permeation (diurnal) test results with the spill-proof spouts installed and containers filled to 50% capacity with CERT fuel. The results revealed two manufacturers producing containers that emit more than 0.40 grams/gallon per day and two manufacturers producing containers emitting lower than the current standard. Further analysis details the reason for the high results. Manufacturer B had one faulty spout of the three containers tested. The results from the faulty spout elevated the average emissions from the line of containers tested. Manufacturer D submitted untreated containers for testing. Also known as pure HDPE, without any type of barrier or treatment, these containers had no barrier against permeation.

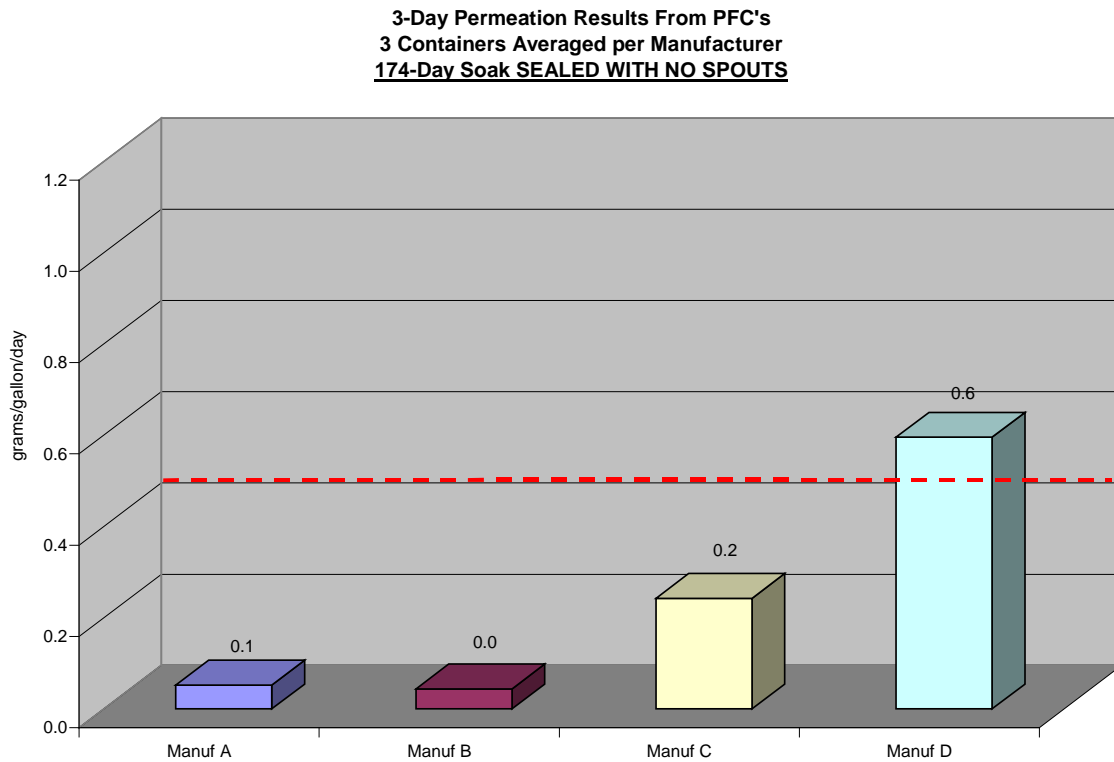
Figure 1 – Combined Evaporation & Permeation (Diurnal) Results



Test Results: Permeation Testing

Figure 2 summarizes the results from testing the same containers with spill-proof spouts removed and sealed using HDPE coupons. Also known as permeation testing, each container was again subjected a 4-day variable temperature (65°F-105°F-65°F) test using a SHED. As seen in the figure below, the results for permeation exceeded the current standard in all cases except one. In one instance, the average daily weight loss was 0.00 grams per day. Similar to the prior combined evaporation and permeation (diurnal) test, Manufacturer D again exceeded the current standard as a result of having no permeation barrier on any of the three containers tested.

Figure 2 – Permeation Test Results



Summary of Test Results

Average Evaporative Loss	0.27	g/gal/day (8 PFC's)
	0.40	g/gal/day (3 Utility Jugs)
	0.30	g/gal/day average (all 11 containers)
Average Permeation Loss	0.10	g/gal/day (8 PFC's)
	0.60	g/gal/day (3 Utility Jugs)
	0.23	g/gal/day average (all 11 containers)
Average Diurnal Loss Rates (permeation + evaporation)	0.37	g/gal/day (8 PFC's)
	1.00	g/gal/day (3 Utility Jugs)
	0.53	g/gal/day average (all 11 PFC's)

Conclusion

As shown in Figures 1 and 2, the use of permeation barrier treatments greatly reduces permeation and overall diurnal emissions from portable fuel containers. Existing technology and currently produced containers can exceed and in some cases, eliminate permeation emissions from portable fuel containers. In some instances, the spill-proof spout may be cause for some evaporative emissions. This is most likely related to quality assurance when producing large numbers of product as staff only identified one faulty spout of the three tested.

Attachment 1

1 Day / 24 Hour / 1440 Minute Episodic Variable Temperature Profile

HOUR	MINUTE	TIME REMAINING (MINUTES)	TEMPERATURE (°F)
0	0	1440	65.0
1	60	1380	66.6
2	120	1320	72.6
3	180	1260	80.3
4	240	1200	86.1
5	300	1140	90.6
6	360	1080	94.6
7	420	1020	98.1
8	480	960	101.2
9	540	900	103.4
10	600	840	104.9
11	660	780	105.0
12	720	720	104.2
13	780	660	101.1
14	840	600	95.3
15	900	540	88.8
16	960	480	84.4
17	1020	420	80.8
18	1080	360	77.8
19	1140	300	75.3
20	1200	240	72.0
21	1260	180	70.0
22	1320	120	68.2
23	1380	60	66.5
24	1440	0	65.0